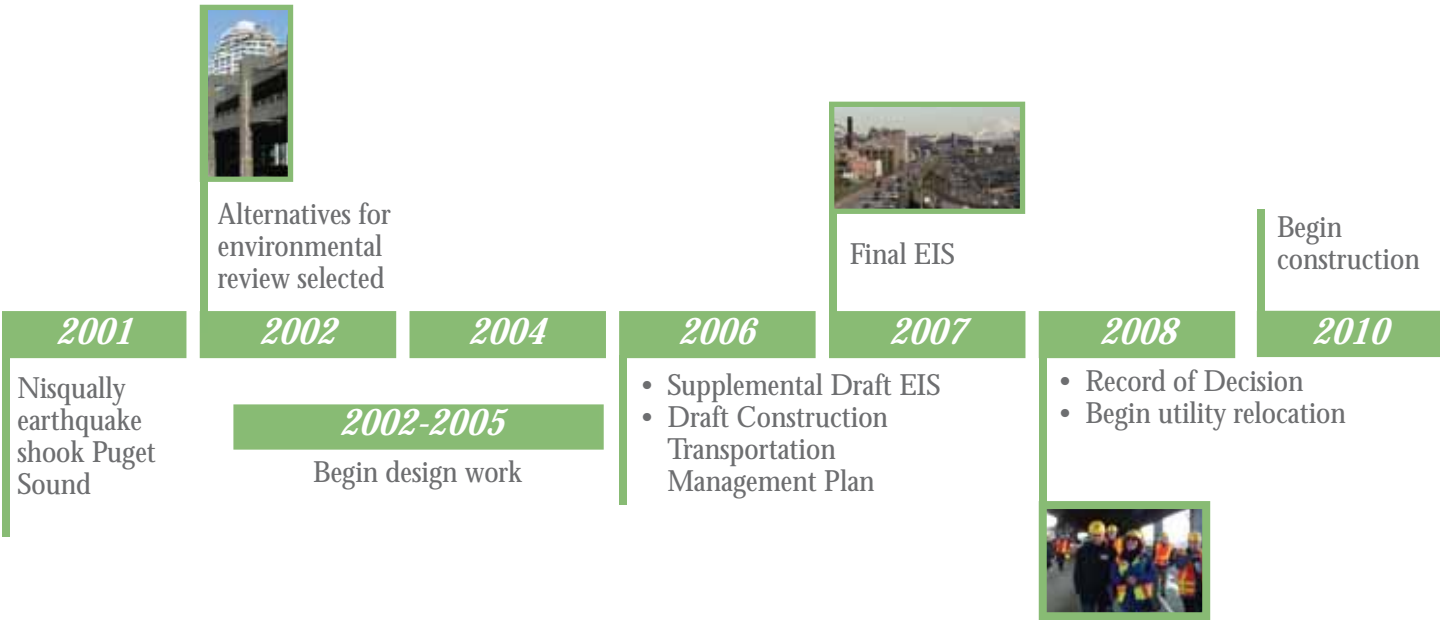


Project Timeline



Community Outreach

Contact Us:

Visit: www.wsdot.wa.gov/projects/viaduct
Email: viaduct@wsdot.wa.gov
Call: the project information line at 206-269-4421
Write: Alaskan Way Viaduct and Seawall Replacement Project
c/o Washington State Department of Transportation
999 Third Ave, Suite 2424, Seattle, WA 98104

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The Alaskan Way Viaduct & Seawall Replacement Project

09.06

A Retrofit is Not Enough

Several proposals have been made to retrofit the Alaskan Way Viaduct. A specific proposal was made by Victor Gray and the Viaduct Preservation Group in December 2004. WSDOT hired T.Y. Lin International to conduct an independent review of the proposal to determine if it would meet the earthquake standards used for Washington state bridges.



Streetscape rendering of the viaduct with the retrofit proposal.

What did the independent review find?

T. Y. Lin International found that the proposal to retrofit the viaduct makes some improvements, but doesn't go far enough to ensure the public is safe when an earthquake hits. A retrofitted viaduct would be damaged beyond repair and may in fact collapse in the event of a strong enough earthquake – experts predict there is a one in ten chance of this earthquake happening in the next 50 years.

What retrofit proposal was evaluated?

The Viaduct Preservation Group submitted a proposal in December 2004 to WSDOT that involved use of supplemental steel frames with shock absorbers, and soil improvement. On June 6, 2006, the Viaduct Preservation Group submitted another proposal that was slightly different from the earlier version.

An extensive analysis was performed based on the earlier proposal. When that analysis was compared to the June proposal, it was found that the revised proposal corrected

some problems, but created others that had not been addressed in the December proposal. The proposal included the following elements:

- Installation of steel strengthening frames running crosswise and lengthwise at the middle columns and bays of each viaduct section. The viaduct is made up of independent sections approximately 220 feet long. The proposal evaluated did not include specific dimensions for these pieces of steel so T. Y. Lin International estimated the appropriate sizes.
- Wrapping of steel jackets around the base of some of the columns to provide additional strength to the structure. T. Y. Lin International believed these jackets would be required for all of the columns and so added them to the proposal.
- Placing of shock absorbers within the middle bay of the viaduct. Additional shock absorbers were shown between adjacent sections to prevent them from banging into each other during an earthquake. Because the evaluation looked at one section of the viaduct, these were not included. However, T. Y. Lin International concluded that these shock

A Retrofit is Not Enough

absorbers may serve to “lock” the sections together, synchronizing the movement of each section together without dissipating any of the energy generated by the earthquake.

- Ground improvements were included, but soil improvements were not explicitly included in the evaluation. T. Y. Lin International observed that these improvements may adversely effect the movement of the foundations.



Rendering of retrofit proposal for area under the viaduct.

What standards were used to evaluate how well the proposed retrofit would work?

The retrofit proposal was evaluated for performance during three different magnitudes of earthquakes.

- The first earthquake is a moderately bad earthquake – one that has a greater than one in three chance of occurring in the next 50 years. The Nisqually earthquake in 2001 had a slightly greater intensity than this earthquake. Bridges should survive this earthquake without any significant damage.
- The second earthquake is a bad earthquake – one that is used as a benchmark to establish the minimum seismic standards for engineering design. Using this standard, bridges will not collapse in an earthquake of this magnitude and only minor repairs may be necessary before it is reopened to traffic. This earthquake has a one in ten chance of occurring in the next 50 years. By comparison, the Nisqually earthquake in 2001 was less intense than this level of earthquake.
- The third earthquake evaluated is a very bad earthquake. This earthquake has a two percent chance

of occurring over the next 50 years. When bridges are built to these standards, it means that they will not collapse even though they may suffer serious damage that would require major repair or even full replacement.

How did the retrofit proposal perform?

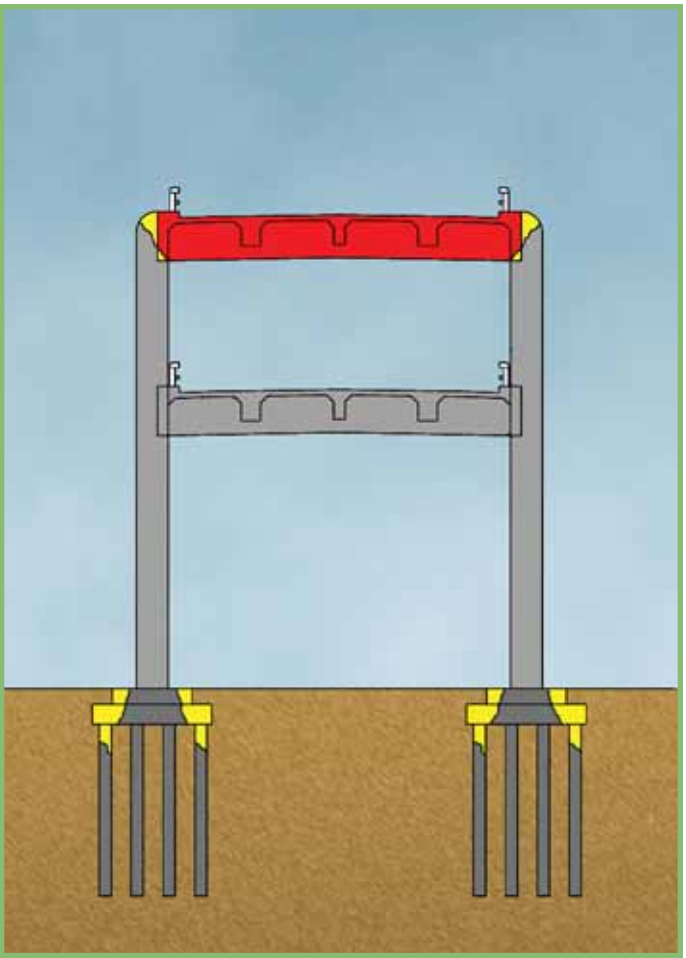
For the moderately bad earthquake, the evaluation shows that even with a retrofit, there may be damage to the viaduct’s foundation elements that will need repair.

For the bad earthquake, the evaluation shows that even with a retrofit, there is a high likelihood that the viaduct would be severely damaged and may collapse. The reasons for this damage and likely collapse are:

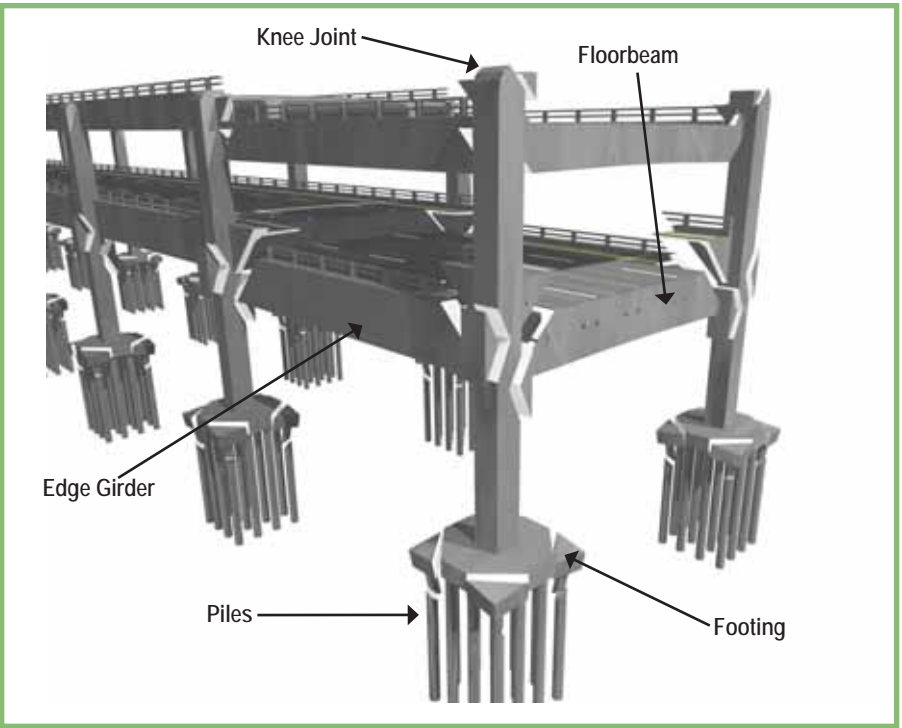
- Piles supporting the viaduct may begin to fail due to rocking of the structure. This rocking is increased somewhat due to the addition of the retrofit framing.
- Footings supporting the viaduct may shear off at the pile connections due to the same rocking motion that overloads the piles.

For the very bad earthquake, the evaluation shows that the retrofitted viaduct will collapse, likely causing loss of life. The reasons for this collapse are:

- The footings of the viaduct would be subject to higher shear and flexural demands, and higher joint shears than for the bad earthquake. Severe damage of the footings is likely.
- The piles would be subject to higher compressive forces that cause severe damage to the footings.
- The columns will rock on the pilings, which they were not designed to do. This rocking may result in severe impacts to the adjacent viaduct sections. The columns are very brittle and the loads from the rocking plus the damage to the footings would likely cause the viaduct to collapse.
- Other parts of the viaduct will also be severely damaged and could fail. For example, the floorbeams will suffer from negative bending at the connection with the columns. The knee joints – some of which failed in the Nisqually earthquake – could also fail



Shown in red is the expected damage for the design for 500-year earthquake.



The viaduct has many weak points that could cause it to collapse in a very bad earthquake.

How much would a retrofit cost?

Because the evaluation did not find the retrofit proposal to be a viable solution, it was not estimated to give an apples-to-apples comparison to the current project alternatives. Previous estimates of a full retrofit that came closer to meeting the earthquake standards were between 80 and 90 percent of the full replacement. Even though it would cost nearly as much, it would not last as long, and it would not provide wider lanes and shoulders to keep traffic moving.

If the viaduct isn’t retrofitted, what might happen?

WSDOT understands the urgency of replacing the viaduct as quickly as possible. Retrofit seems like an easy solution, but the risks to public safety would still be with us. We don’t think the public, decision makers, and elected officials would be comfortable with a retrofitted viaduct that would likely cause loss of life in a bad earthquake.

What are the next steps?

The WSDOT Bridge Office will work with the Viaduct Preservation Group and a panel of independent civil engineers to determine what improvements could be made to the proposal to meet today’s earthquake standards. Depending on the outcome of this work, additional evaluation and engineering work may be completed